Title: A compact 4 x 4 butler matrix on double-layer substrate

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Abstract: A novel 4 x 4 Butler matrix (BM) on double-layer substrate is presented. The design of the multilayered BM configuration successfully removes the need for a crossover component by utilizing a double-layer substrate structure. With the elimination of the crossover, space consumption by the microwave circuit of the BM is reduced significantly. The BM is developed by means of four proposed 3-dB compact couplers using dual transmission lines on a double-layer substrate and two 45 degrees phase shifters. The proposed BM components are designed using CST Microwave Studio 2010 and fabricated using inexpensive FR-4 substrate to operate at 2.45 GHz. The simulated and measured performances in terms of S-parameters and phase differences for each 3 dB coupler, 45 degrees phase shifter, and BM are presented. Good agreement in beam direction results between the MATLAB (matrix laboratory) simulator and measurement is accomplished with a deviation of +/- 8 degrees.